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REPORT OF
THE ENTOMOLOGIST
FOR
1912.

By L. O. HOWARD.

[From Annual Reports of the Department of Agriculture.]

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REPORT OF THE ENTOMOLOGIST.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., July 1, 1912.

Sir: I submit herewith an executive report covering the work of the Bureau of Entomology for the fiscal year ending June 30, 1912, dividing it, in accordance with your instructions, under the following heads:

(1) A summary of the important work carried on during the fiscal year ending June 30, 1912.

(2) An outline of plans proposed for work during the fiscal year ending June 30, 1913, under appropriations already made for that year.

(3) Plans of work recommended for the fiscal year ending June 30, 1914.

Respectfully,
L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

WORK OF THE YEAR.

There has been no change in the classification of the work carried on under the bureau; it remains the same as that submitted in the last report of the bureau, as follows:

(1) Work on the gipsy moth and the brown-tail moth.
(2) Importations of useful insects.
(3) Exportation of useful insects.
(4) Work on insects injurious to southern field crops.
(5) Investigations of insects damaging forests.
(6) Investigations of insects damaging deciduous fruit trees.
(7) Cereal and forage-plant insect investigations.
(8) Work on insects affecting vegetable crops.
(9) Work on insects affecting citrus fruits.
(10) Investigations of insects in their direct relation to the health of man and domestic animals.
(11) Work on insects injurious to stored products.
(12) Inspection work.
(13) Work in bee culture.
(14) Unclassified work.

WORK AGAINST THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

It was pointed out in the last report that a most important series of experiments had been begun with regard to the relative resistance of native trees to the attack of the gipsy moth. This work has been continued. It was shown that although the listed food plants for the gipsy moth included almost all of our native plants, it is beginning to be found out that certain species are resistant and even immune to the young larvæ. Experiments were detailed whereby, after the removal of favored food plants, a 17-acre tract of chestnut was perfectly protected, and in the same way that in another experimental tract of coniferous trees the removal of the favored food plants, particularly scrub oak and birch, left the valuable forest unattacked and practically immune. The basic idea of this work and that which has been subsequently carried on, and which must continue for some time, is to develop a system of forest management which will obviate the forest stripping which is now going on in the mixed forests of parts of New England and to protect in a large measure by this very system the stand of the trees.

Over 250 localities have been selected in different parts of Maine, New Hampshire, and Massachusetts, where different conditions of infestation exist. These places are being carefully examined from time to time in order to determine the increase of the species under varying conditions and to secure a more thorough knowledge of the feeding habits of the caterpillars. In the laboratory 50 different kinds of trees and shrubs native to New England are being used in feeding tests, and a number of other tests are being carried on to determine the behavior and development of the caterpillars when the woodland is thinned to clean stands of different species of trees. It will be necessary for the outdoor experiments to be continued for several years in order to obtain exact data, but it is already perfectly plain that the information gained in this way will have a direct bearing on the proper methods of thinning woodland in order to prevent serious gipsy-moth devastation, while it will also guide in forest planting; and, moreover, data which are gained in these experiments will determine the rate of reproduction under normal conditions for comparison with the rates in places where parasites have been liberated in the fields.

The actual work of the bureau in preventing the spread of the gipsy moth and the brown-tail moth has been carried on in the same way as in previous years. The apparent increase in the area infested by the gipsy moth has been less than in any years since 1905. The newly infested area in Maine is greater than that in all of the other States together. The spread there is attributed principally to the carrying of the very small caterpillars by the wind. With the exception of three towns in western Massachusetts (Lenox, Stockbridge, and Great Barrington), all of the new colonies which have been found are in towns contiguous to the previously known infested area. In Rhode Island the spread has been mainly toward the south, along both sides of Narragansett Bay.

While the efforts of the bureau have been directed almost entirely against the gipsy moth, the brown-tail moth has not been ignored; but as its spread by flight seems to be inevitable, concentration upon the gipsy moth seems desirable.

The authorities in all of the infested States are cooperating with the bureau in the same way as pointed out in previous reports.

The work which has been done has consisted in cleaning up the land along the roadsides, by the removal of underbrush, and, so far as possible, the favorite food trees, creosoting of gipsy-moth egg-clusters, and spraying at the proper time of the year. This work has gone so far, although there is still some roadside work to be done through the woodlands, that it seems the time will soon come when more time can be devoted toward other methods of spread than by carriage of caterpillars dropping from trees upon vehicles passing over the main-traveled roads leading through the most densely infested territory.

The inspection of shipments of various forest products from the infested area to points beyond has been continued, since this is one of the important methods of preventing the spread for long distances. Nurseries in the infested districts are inspected for the most part by the States, but where the State service is not sufficient, employees of the bureau are detailed for this purpose. Thus, during the autumn of 1911 and the spring of 1912 several men were loaned to the Massachusetts nursery inspector for this work, and during the past winter a cleaning up of the woodland around the borders of the more important nurseries has been completed. The underbrush, poor trees, and, so far as possible, favorite food trees have been removed, to prevent the breeding of the moths and to lessen the danger of the nursery stock becoming infested from the surroundings. The trees left growing in these areas are treated with sticky bands, and are being watched carefully during the summer of 1912, and all larvæ are being destroyed. Applications have been made for shipments of forest products of different kinds, and from material examined egg-clusters and larvæ of the gipsy moth have been removed. Further in this general direction, during July, 1911, when the brown-tail moths were flying, agents of the bureau were detailed to examine at stations on the border of the infested area railway trains running from the badly infested territory. As the moths are attracted to light, it seems quite probable that enough moths may fly into passenger trains, where they may ride for long distances, to establish new and important colonies beyond the infested border. During the flight season in this way 887 adult brown-tail moths were taken from trains.

Some experiments with new spraying compounds, with material for sticky bands, and with preparations to use in the place of creosote for treating egg clusters of the gipsy moth have been tried, but none of them has been shown to be better than the material already in use.

During and immediately following the hatching period of the gipsy moth in 1912 unusually high south and southeast winds prevailed, from which there has probably been considerable spread of the small larvæ.

The gipsy-moth situation as a whole seems to be better than in the past two or three years. Less woodland is being defoliated and the public is not so much disturbed. The brown-tail moth does not seem to be so serious a pest over a large part of the territory infested as it was two years ago. There are yet many places where it has caused serious damage and discomfort to the people, especially, perhaps, in the summer resorts in New Hampshire, but fewer complaints are heard of brown-tail rash, and the public press now hardly mentions it.

FIELD WORK BY STATES.

The 1911–12 work in Massachusetts has been the continuance of cleaning along woodland roadsides and their care through the caterpillar season by banding with sticky material and spraying with arsenate of lead. This is the same work that has been in progress for nearly six years. The principal routes of travel have been nearly all covered, and less of this work will be needed during the coming season. It is proposed now to give more attention to an attempt to exterminate the gipsy moth along the western border of the infested region. This work has already been begun, and towns on the border have been examined by scouts during the present year and the infested localities have been cleaned up and put in shape for attention during the season. Fifteen to twenty men were kept in the extreme western part of the State most of the winter to examine carefully the Berkshire region for the gipsy moth, which had been discovered there in the towns of Lenox and Stockbridge in August by men in the employ of the forestry contractor. Most of the work in these two towns has been done by State and town employees. Scouts in the employ of the bureau found the gipsy moth in Great Barrington, which adjoins Stockbridge on the south, in November, 1911. An extensive colony of brown-tail moths was found in North Adams, and this was gone over by employees of the bureau and all winter webs which could be found (approximately 13,000) were destroyed. Both gipsy moth and brown-tail moth have been found, during the past season, close to the New York border.

In New Hampshire scouting work and creosoting egg-masses was carried on in the early winter, but, owing to deep snow and unusual cold, it was abandoned in January and could not be resumed until April. The outer edge of the infested territory has been carefully worked over, as in previous years. A few towns in the northern and western border, formerly infested with the gipsy moth, have been apparently cleared; none of these insects has been found for two years past.

In Maine the severity of the winter interfered seriously with work, just as it did in New Hampshire. In January men were transferred from this State to Rhode Island and returned in April. The area infested by the gipsy moth in this State seems to have increased considerably during the past year, although not quite so much as in the preceding year. Most of the spread is attributed to the wind, the minute caterpillars floating in from badly infested areas south and west. No large forest areas have been defoliated, and, while the gipsy moth occurs over large areas, little real damage is being done by it. The brown-tail moth situation, however, is perhaps more serious in Maine than in any other State.

In Rhode Island some ground was lost; there was no State appropriation for work in 1911, and no summer work was done. More than 100 employees of the bureau began work in this State in January and finished in April. About two-thirds of the State was scouted and approximately 38,000 egg-clusters were creosoted. Five new towns were found infested. Money has been appropriated by the State for 1912, and it is hoped that the ground lost will be regained. The brown-tail moth has spread slightly in this State and the northeastern part is badly infested in spots.

In Connecticut the gipsy-moth situation is most encouraging. The State authorities have been very energetic and have done most of the work. No trace of the moth has been found at Stonington, where a bad colony existed some years ago. At Wallingford, where two years ago 5,000 egg-masses were creosoted, two of the most expert scouts of the bureau in December, 1911, and January, 1912, were able to find only 5 egg-clusters.

IMPORTATIONS OF USEFUL INSECTS.

IMPORTATIONS OF INSECT ENEMIES OF THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

During the fiscal year under consideration the gradual change instituted the previous year in the work of importing insect enemies of the gipsy moth and the brown-tail moth by reducing the number of importations, paying more attention to the study of the intimate relations of certain of the parasites in their native homes, and especially making an effort to study and import species heretofore considered as not especially prominent but which may fill in important gaps in the parasite chain, and further, devoting more attention to the study of the American conditions and rate of spread of parasites previously imported, has been followed up. An important step was taken on December 1, 1911, whereby the work of introducing and colonizing parasites and predatory enemies of the gipsy moth and the brown-tail moth, which had hitherto been carried on cooperatively with the State of Massachusetts, was transferred bodily to the bureau. The arrangement went into effect on that date. At this point it should be stated that the cooperation on this project between the State of Massachusetts and the United States Department of Agriculture, which has been in effect for about 6 years, has been thoroughly satisfactory. Without the assistance of the State the operations could not have been carried on upon so large a scale as has been possible. The most cordial relations have existed and the most perfect facilities have been offered to the experts of the bureau at the expense of the State. The growing importance of the work and the urgent need for the diversion of all possible State funds to other aspects of the investigation have brought about the transfer indicated. The Massachusetts end of the work has been carried on in much the same way as heretofore, a number of State employees having been transferred to the bureau rolls, so that their previous training and experience was available.

During the first half of the fiscal year only a small amount of parasitic material was received from Europe, but although the quantity was small the quality was excellent. Most of this material was wintered at the laboratory, and during the spring of 1912 there has been a good emergence of parasites and several vigorous colonies have been liberated in the field. Especial mention was made in the last annual report of the receipt and liberation of 23,000 specimens of *Apanteles solitarius*, a species which seems to be important in Europe and with which the bureau has been previously unsuccessful. Down to the time of the present writing nothing has been recovered from this liberation, but as past experience has shown, dispersion is often so great and so rapid that recoveries of imported parasites are often not made until the second and even the third year. The nonrecovery of a liberated parasite the first year after liberation by no means indicates nonsuccess. On the other hand, another important parasite, referred to in the last report as having been found by Mr. Fiske in Sicily, although previously known only from Russia and of which 125,000 cocoons were sent over, survived the winter successfully in Massachusetts, and during May and the first half of June, 1912, about 12,000 adults were put out in the field. Another species of Apanteles, which was received in small numbers, passed through the winter in good condition and a small colony has been placed out. The females of this species laid their eggs in small caterpillars and the insect has now passed through a generation since it arrived in this country. Several other species which were imported last year and which were mentioned in the last annual report were colonized during the late summer and autumn of 1911.

The egg-parasites of the gipsy moth which have been colonized during the past two years were both recovered in the field late in the summer of 1911. *Anastatus bifasciatus*, a species having one generation annually and coming from both Japan and southern Europe, was found to be breeding in practically all of the places where it has been colonized. This species spreads very slowly, however, and it is necessary to make many plantings in order that it may become generally distributed. In some of the collections of egg masses as high as 47 per cent of the eggs were found to be parasitized. More than 700 additional colonies of this species have been put out during the spring of 1912.

The distinctive Japanese egg parasite, *Schedius kuvanæ*, especially mentioned in the last report, has been recovered in several localities where plantings had previously been made. In some places an enormous number of the parasites were present and were ovipositing in gipsy-moth egg-masses. This species has several generations each year, and the outlook for its perfect establishment and future spread is more favorable than it was last year. This is especially satisfactory, since 18 months ago it was thought that the insect had been lost and that it had been unable to withstand the New England winter—a most unfortunate situation if it had been true, since it is readily handled in the laboratory and may be reared literally by millions in confinement.

The European Calosoma beetles have become thoroughly established and have caused much destruction among the gipsy-moth caterpillars and pupæ, and in many parts of the infested region they are becoming so abundant that they attract the attention and respect of casual observers.

The parasites of the brown-tail moth have increased and spread over a much larger territory than last year. The trend of dispersion has been in a north and northeast direction, and has followed the same general lines as the brown-tail spread. One species, *Monodontomerus æreus*, has been found beyond the city of Bangor, Me., and as far north as the brown-tail moth has spread in New Hampshire. In Massachusetts and Rhode Island the spread of this species very nearly covers the range of the brown-tail moth. Another one, *Apanteles lacteicolor*, has been recovered from more than four times the area in which it was recorded last year, and is showing a satisfactory rate of increase. Still another, *Meteorus versicolor*, an excellent parasite of the brown-tail moth, has spread more rapidly during the past year than at any time since it was first liberated. The first of the brown-tail moth winter-nest parasites to be found established in this country, and to which frequent reference has been made in these annual reports, namely, *Pteromalus egregius*, has also shown a good increase and spread over the previous year.

In the furtherance of the proposed study of European conditions, especially regarding parasite control there, Mr. W. F. Fiske, with two expert assistants, has been located in southern Europe since December, making his headquarters in Italy and traveling through southern Germany, Austria, and France, securing data and ascertaining the best points in which to make studies and from which to send material during the present summer.

ATTEMPTED IMPORTATION OF INSECT ENEMIES OF THE WHITE FLY.

The discovery of what is apparently the original home of the white fly of the orange in India was announced in the last annual report, and the discovery of certain natural enemies was mentioned. Two of these important enemies, namely, an internal parasite and a predaceous lady-beetle, were successfully brought from India to Florida by Mr. R. S. Woglum, of the bureau, and in good numbers, in the autumn of 1911. Apparently, however, they failed to survive the winter. This failure was most unfortunate, and probably can be obviated from the experience now gained in the case of future shipments. The winter of 1911–12 was exceptionally severe, and Florida climatic conditions were quite different from those which hold in the original Indian home of the parasites. It is probable that better success will come by importing this material not later than midsummer rather than in the autumn, or, if an autumn importation is again found necessary, by establishing such conditions in Florida as will be favorable for active breeding during the winter instead of attempting to carry these beneficial insects through a condition of hibernation, as was done with this first sending. It must be frankly said that it is not expected that these beneficial insects will prove a complete remedy for the white fly in Florida or elsewhere, but there is a possibility that they will be useful, and until this possibility has been fully demonstrated one way or the other it will probably be worth while, at a favorable time, to repeat the experiment. Definite knowledge of the apparent failure of the experiment was gained too late to make it desirable to send another expedition the present year.

IMPORTATIONS OF PARASITES OF THE ALFALFA WEEVIL.

The Italian parasites of the alfalfa weevil sent over in March and April of 1911, referred to in the last annual report, have made little progress. During the spring of 1912 an agent was sent to join the gipsy-moth parasite party in southern Europe, and during the early months of the present year the attention of the gipsy-moth parasite experts was also diverted to some extent to the investigation of the possibilities of importing alfalfa-weevil parasites. As a result a much larger number of parasites of the alfalfa weevil have been brought over from Italy, Germany, and Switzerland than it was possible to obtain last year. A stronger and better-trained force of men has been stationed in Utah to handle the material received, and during June of 1912 the imported parasites were being reared in Utah from alfalfa stems and other material received from Europe and were being liberated into the fields infested by the weevil—a course that was impossible last year on account of the limited amount of material imported. There seems little doubt, from the investigations in Italy during the spring of 1911 and the spring of 1912, that the weevil is largely controlled in that country by its native parasites. It remains to be seen whether a similar condition of affairs can be brought about in our Western States, which depend so largely upon their alfalfa crop and which differ so greatly in many places from the climatic conditions of Italy. The attempt seems to be well worth while when carried on simultaneously with remedial efforts in other directions.

EXPORTATIONS OF USEFUL INSECTS.

During the year parasites of scale insects have been sent to Peru, to Argentina, to Italy, and to Spain. Parasites of tobacco insects have been sent to the Tobacco Planters' Association of Deli, Sumatra, and an egg-parasite of one of the important tobacco pests has reached Sumatra in good condition via Amsterdam and has been liberated in living condition. The spread of the brown-tail moth in the Province of New Brunswick was mentioned in the last annual report, and brown-tail moth parasites, introduced into this country from Europe and established in New England, have been sent to New Brunswick, to an agent of the Central Experimental Farm of the Dominion of Canada, who has liberated the parasite material, which gives promise of success equal to that of New England.

During the year the results have been announced of the importation into Italy from the United States, through this bureau, of an internal parasite of a scale insect which promised the destruction of the mulberry plantations in that country. Dr. Antonio Berlese, of Florence, in a recently published paper in which he goes into the question of the spread of this American parasite in Italy, announces the following conclusions: (1) The American parasite is perfectly adapted to the climate of upper Italy; it multiplies more actively in the milder regions than in the colder regions, having probably one or two generations less in the latter; (2) excessive cold, however, is not injurious to the parasite; (3) the diffusive intensity of the parasite is so great that it will disperse throughout upper Italy even without being aided artificially. During the present year the States of Liguria and Venetia will be for the greater part freed from the scale. The same condition will be reached for Lombardy in 1913 and for Piedmont in 1914.

It becomes more apparent every year that the United States, by aiding foreign countries in this way, is not only performing a courteous and helpful service to others, but is most emphatically benefiting itself, since return service of a similar kind and of an important nature is willingly and courteously rendered.

WORK ON INSECTS INJURIOUS TO SOUTHERN FIELD CROPS.

The work on insects injurious to southern field crops dealt with six specific lines of investigation, as follows: (1) Cotton-boll weevil; (2) tobacco insects; (3) sugar-cane insects; (4) the Argentine ant; (5) rice insects; (6) the cotton red spider. In addition several miscellaneous problems received attention. The work of this section has been carried on as before under the supervision of Mr. W. D. Hunter.

THE COTTON-BOLL WEEVIL.

The work on the cotton-boll weevil problem consisted of the testing of control measures, both direct and indirect, such as the encouragement of parasitic enemies; the determination of the status of the insect from time to time throughout its range; the mapping of the new territory invaded; and various incidental matters.

The experiments in practical control were conducted largely in the Mississippi-Yazoo Delta, where a laboratory was maintained throughout the season. On typical plantations in this region extensive series of tests were instituted to determine the value of hand picking the early appearing weevils and the infested squares. Some years ago the practice was tested thoroughly in Texas, with the result that it appeared to be extremely doubtful whether the benefit to the crop would ever offset the expense involved. In Louisiana and Mississippi, with conditions quite different from those in Texas, the practice may be found to be more feasible. The experiments of the season dealt with pickings beginning at different dates in the spring, continuing to different dates in the summer, and with different time intervals between the pickings. The work was designed to determine at what date the work could be begun to advantage and when it should be discontinued, and also whether a period of 5, 7, or 10 days between the pickings would be the most advantageous. The experiments were conducted under practical conditions on different plantations and supplied a large amount of data. The work of the season, taken in connection with results obtained previously and others that will be secured, will show accurately what may be done by this practice under different conditions of season and plantation management.

The experiments to determine whether the burial of the cotton stalks or the infested squares can be depended upon to take the place of the burning of the stalks were continued. As in the square-picking experiments, this work was conducted on several plantations in the heavily infested territory. It was found that within certain limits approximately the same results as follow from burning of the plants could be obtained by deep plowing. This was noticeably the case in plowing under the infested squares at the time the weevils become so numerous as to destroy all of the fruit as it formed. The value of the process depends upon local conditions of soil and rainfall. The results of the season's work add considerable definiteness to the information that has been available hitherto and promise to show one method whereby the loss of organic matter incident to the burning of the stalks may be avoided.

Experiments in poisoning the boll weevil by means of powdered arsenate of lead and other arsenicals were conducted on several plantations. About 135 acres were utilized in the plats. In some cases the experiments resulted in a practical advantage to the planter; in others there was a loss. In general, however, a profitable outcome resulted where the number of applications was small. This indicates that there will be a distinct field of usefulness for the poison against the weevil, but many questions regarding the practical application of the method remain to be worked out.

The work on the parasites of the boll weevil consisted of life-history investigations of a number of species, the introduction of certain forms from the older infested territory into the humid region, and the local concentration in that region of parasites already present.

The investigation of the life-history and habits of the boll-weevil parasites is necessary to reveal feasible means of propagation and introduction. Along this line very satisfactory progress was made. The work in parasite introductions consisted of the shipments to Louisiana of large quantities of weed stems infested with parasitized weevils related to the boll weevil. This work was done during the winter, and observations were made in the spring and summer to determine whether the introduced species were able to maintain themselves. The experiments in local concentration of parasites consisted of the collection of large quantities of cotton squares in the immediate vicinity of the point where the experiments were conducted and their concentration in suitable release cages in limited areas on the plantations. As in the case just mentioned, a very large amount of work was required to obtain the material and to make the detailed observations that were necessary in order to interpret the results.

During the season considerable work was done toward bringing about uniformity in the quarantine regulations designed to prevent the introduction of the boll weevil into States or parts of States that have not become infested. The outcome was a meeting held in Atlanta, Ga., during December, 1911, at which the representatives of the States concerned reached an agreement regarding a uniform system of quarantines which will remove many of the objections to the various systems that have been in effect.

As has been the case in previous years, there was considerable demand for information concerning the exact status of the boll weevil during the season. To supply the information it was necessary for agents of the bureau to make careful examinations throughout the infested territory. The approximate number of weevils hibernating successfully was thus determined by early field examinations, and the probability of damage in different localities was forecasted. This information was utilized extensively by planters and the cotton trade generally.

The agents of the bureau obtained accurate records of the experience of a large number of practical planters in producing cotton under boll-weevil conditions. These records dealt with the cultivation of a number of varieties under different conditions, planting at different dates, variations in spacing, and many other cultural practices. The records will be used in due time to supplement the records of the accurate field experiments of the bureau.

TOBACCO INSECT INVESTIGATIONS.

The principal work on tobacco insects consisted of investigations of means of control of the so-called hornworms and demonstrations based thereon, the demonstration of methods of control of the tobacco wireworm in Virginia, a study of the control of the cigarette beetle, and a preliminary investigation of the causation of the so-called mosaic disease of tobacco by insects. The main work of the investigations was conducted at Clarksville, Tenn., while the work on the wireworm was centered largely at Appomattox, Va.

The principal work on the hornworm was designed to furnish satisfactory means of control by chemicals. A large number of arsenical preparations were tested. In several instances these preparations were made up especially for the bureau by manufacturing chemists. It was fully determined and demonstrated on a small scale that arsenate of lead is an almost perfect remedy for the hornworm. This discovery will eventually cause the discontinuance of the use of Paris green, which, though generally used, has been found to do damage to the tobacco that has not been appreciated. In this work indications were obtained that poisons even more satisfactory than arsenate of lead may be found as the result of future investigations.

The demonstrational work, which was necessarily conducted on a small scale on account of the shortage of funds, was well received by the planters and will undoubtedly result in the adoption of greatly improved methods.

The work on the cigarette beetle revealed the fact that the pest is of considerably more importance than has been supposed. It was possible to utilize only a small portion of the time of one agent on this work. As opportunities arose, however, experiments with different fumigants and in attracting the beetles by various means in the warehouses were instituted.

The work on the tobacco wireworm in Virginia was restricted largely to the investigation of means of direct control and demonstrations. All experiments and observations have shown that the most effective control consists of freeing land from such weeds as are the natural food plants of the insects. It was found that this could be brought about by several methods. One of them is a proper rotation of crops; another, the summer plowing of the fields; and another, the use of lime. In the experiments with lime it was found that sheep sorrel, one of the plants upon which the wireworm breeds in great abundance, would not grow where even a comparatively small amount of the substance had been applied. The lime also had a remarkable effect in decreasing the number of other natural food plants of the wireworm. These results will form a foundation for a system of control that will be well adapted to the conditions in the tobacco regions of Virginia. A large number of experiments with insecticides against the wireworm were conducted, but without satisfactory outcome.

SUGAR-CANE INSECT INVESTIGATIONS.

The work of the investigation of sugar-cane insects dealt largely with the borer, which is by far the most important enemy of the crop in the United States. It has been supposed that this species attacks corn and sugar cane indiscriminately. Early in the season, however, the question arose as to whether the insect infesting corn was not distinct from that injurious to sugar cane. The means of control that have been suggested were based upon the supposition that the borers in corn and sugar cane were the same. It therefore became necessary to investigate the matter thoroughly. At the laboratory at New Orleans experiments soon showed that the same insect attacks corn and sugar cane in that vicinity. It is therefore clear that the two crops must be taken into consideration in any plan of control.

An experiment was undertaken on the grounds of the Louisiana Sugar Experiment Station, near New Orleans, to bring about the total eradication of the cane borer. The conditions at this point were ideal for an experiment of this kind, the results of which could be applied in varying degrees on all sugar plantations in the South. In this experiment it was planned to exclude all cane that was not fall planted, to collect and burn all trash, cane tops, and similar débris left in the field, to uproot and destroy the stubble, so that no cane except that fall planted would occur on the grounds, to do away with windrowing the canes, and to plant the corn on the station grounds later during the season in order to deprive any of the moths that might have survived the operation described of any opportunities for breeding. This experiment, which has been made possible by the hearty cooperation of the Louisiana Sugar Experiment Station, when completed, will be of the utmost value to planters in the control of an insect which causes a loss of several hundred pounds of sugar per acre throughout the greater portion of the cane belt.

Another effort was made to introduce an important insect enemy (*Cryptolæmus montrouzieri*) of mealy bugs to attack the sugar-cane mealy bug in Louisiana. One shipment was obtained from California and released in a plat of cane at the experiment station. Another was liberated at Adeline, and a third in a large hothouse at Audubon Park. The individuals in all of these shipments seemed to thrive for some time after they were introduced and two generations were reared. However, the winter conditions were evidently not suitable for the insects, as none survived. These experiments seem to demonstrate that there is no hope of obtaining control over the mealy bug in Louisiana by the introduction of the Cryptolæmus.

The work on sugar-cane insects was conducted in close cooperation with the Sugar Planters' Association of Porto Rico. That association sent an agent to southern Mexico to obtain parasites of the borer. Such enemies of the insect are entirely absent in Louisiana. Any material that is obtained by the Porto Rico station will be shared with the bureau for experiments in introduction in Louisiana. In line with this cooperation the bureau assisted in the shipment of the predatory beetle *Cryptolæmus montrouzieri* to Porto Rico. This species, as has been noted, failed to establish itself in Louisiana, but it was supposed that the conditions in Porto Rico might be more favorable. Large numbers of specimens were obtained from California for forwarding to Porto Rico. At New Orleans they were fed and repacked for shipment. The reports from Porto Rico up to the present time indicate that the introduction will probably be successful.

WORK ON THE ARGENTINE ANT.

The main line of work undertaken on the Argentine ant was a large-scale test of a method of extermination which appears to have been followed successfully in California. The method in brief is to expose jars containing a very dilute mixture of sodium arsenite with sugar so that the ants will visit them and be poisoned. In the work in California the mere placing of receptacles containing this preparation appears to have resulted in the extermination of the ants. At Hattiesburg, Miss., this method was tested on a series of colonies of the ant which infested about five city blocks. Several hundred jars containing the poison mixture were exposed during the fall of 1911, under a cooperative agreement with the city authorities. This method shows its effects slowly and it will be necessary to prosecute the work through another season to determine whether it is an effective method of combating the ants. Another line of work was directed against the ants in orange groves, where they have been the indirect cause of the loss of many trees. The system of traps described in the preceding annual report was tested on a considerable scale and its practicability within certain limits was demonstrated. Other work relating to the Argentine ant consisted of the determination of the spread, experiments with a large number of poisons that had not hitherto been tried, and the relation between the ant and other insects. In connection with the last study it was determined that the ant protects the sugar-cane mealy bug and thereby becomes of importance in connection with cane culture. In the orange groves it protects the plant lice feeding upon the trees and at the same time drives away the enemies of the plant lice and of other insects destructive to the trees. In addition to the weakening and death of many of the orange trees in the manner described it was found that the ant indirectly causes the trees to be more susceptible to frost. In a number of cases where observations were made on trees to which the ants had access and where, consequently, the enemies of the trees were protected, considerable loss from freezing occurred during the winter, while trees from which the ants had been excluded were not affected. Substantial progress was made in the control of the ant in orange groves by the use of special sticky mixtures applied with brushes to the trunks of the trees.

RED SPIDER ON COTTON.

The work on the red spider on cotton was conducted at Batesburg, S. C., although the agent engaged in this work made a survey at the end of the season to determine the extent of red-spider injury in other States. At Batesburg the principal efforts were directed toward practical demonstration of economical means of control. Success was attained by several methods. Previous findings in regard to the importance of cultivated violets in carrying the spiders through the winter were verified. Where the pests were destroyed on the violets in dooryards it was found that such infestations of adjoining cotton fields as had been of regular annual occurrence were prevented. In another experiment the wild plants which support the cotton red

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spider and grow in the immediate vicinity of cotton fields were destroyed by burning before the infestation of the cotton field had begun. By this means the spider was destroyed and no infestation of the cotton field occurred. Methods were also devised for use in cases where it has not been possible to prevent the invasion of the fields. In one experiment the first few cotton plants that became infested were pulled out, carried from the field, and destroyed. In this way a single field which had shown damage each season was kept clear. In another experiment the plowing under of cotton planted broadcast near the edge, which served to concentrate the spiders on their migration from the original host plants to the cotton, checked the invasion completely. It was also discovered that the use of a solution of potassium sulphid in water is an economical and effective method of destroying the spider when it has invaded a field. By this means the agent engaged in this work prevented the spread of the red spider by the application of a spray which cost only 75 cents per acre.

The survey of several of the eastern cotton States to determine the amount of damage caused by the red spider, to which reference has been made, resulted in a determination of the fact that injury is spread over a very wide territory. Throughout the States of North Carolina, Georgia, Florida, Mississippi, and Alabama the spider was found in the cotton fields. In many places in these States the injury was as severe as in South Carolina. It has generally been overlooked by planters or considered to be some sort of rust.

RICE INSECTS.

The work on rice insects was conducted at Crowley, La., where excellent facilities were furnished by the Louisiana experiment station. The main work on rice insects was with the so-called rice water-weevil. In addition to the study of the life history of the pest, considerable work was done in practical control by management of the water. It was found that the weevil is checked to a very considerable extent by such draining of the fields during the growing season as is not sufficient to affect the rice materially. These observations have led to an extensive series of experiments to determine exactly how the water used in flooding the fields may be manipulated to check or greatly reduce the ravages of the weevil.

Observations were made on a number of minor enemies of the rice plant, some of which will eventually require careful consideration. Up to the present time, however, it has been necessary to concentrate the work on the principal species affecting the crop.

MISCELLANEOUS.

During the year an opportunity arose for testing various forms of electricity, including Roentgen rays and high frequency currents, for their possible utility in the destruction of injurious insects. The work dealt largely with the determination of the possibility of sterilizing insects by means of Roentgen rays, as it was to be assumed that insects might be affected somewhat in the same manner as human beings are known to be. A rather elaborate apparatus was placed at the disposal of the bureau and tested at New Orleans. The results, although extremely interesting from a scientific standpoint, did not reveal any points of practical value. It was found that the Roentgen rays have apparently no effect whatever on the sexual organs of the insects.

At the Dallas laboratory much work was done to determine the relative toxicity of a large number of poisons on different species of insects. In this work the killing dose, the physiological effects on the insects, and the effects on the soil were considered.

In cooperation with the South Carolina experiment station work in the practical control of the cotton root-aphis and cotton wireworm was conducted at Marion, in that State. Some of the results have been published by the South Carolina station.

During the season there was an unexpected outbreak of the cotton caterpillar throughout the Southern States. This insect was formerly the most dreaded enemy of cotton in the United States, but for about a quarter of a century has not attracted much attention. During the year, however, there occurred an outbreak practically as extensive as any that had been recorded. Observations on this phenomenon were made and through publications and letters advice was given the planters regarding the control measures to be practiced.

INVESTIGATIONS OF INSECTS DAMAGING FORESTS.

The work of the bureau on insects affecting forest trees and crude and finished forest products has been carried on during the year under the direct supervision of Dr. A. D. Hopkins, as in previous years, and the same general lines have been followed. There has been a continued effort to demonstrate the practicability of preventing a large percentage of the waste of forest resources heretofore caused by insects, and there has, in consequence, been a greatly increased interest in the subject on the part of small and large private owners of timberlands as well as by State and Federal officials who are charged with the management of public forests. There has been a more general adoption of insect-control policies in connection with other advanced methods of forest protection, and also a more general confidence in expert advice on matters relating to the control of injurious insects.

The principal injuries of the year have been, as before, by the Dendroctonus beetles on the pine, spruce, and fir of the Northwest and Pacific Coast States, and on the pine of the South Atlantic and Gulf States. In sections where no attempt has been made by private owners or public officials in charge to control the depredations a great waste of forest resources has continued, but in certain sections where proper efforts have been made in the way of control the waste has been reduced or entirely stopped. The hickory barkbeetle has caused the death of a large number of young and old trees in the North Atlantic and Great Lakes States, but information given out from the bureau has resulted in a large amount of successful control work carried on by the owners of woodlots and by superintendents of municipal and private parks.

The ravages of the so-called chestnut bark disease attracted a great deal of attention during the year, and recent investigations have indicated that certain insects with bark-boring habits are intimately associated with this disease and with other diseases affecting the chestnut. In fact, the evidence seems almost conclusive that the infection of the living tissue and the ultimate destructiveness of the disease is largely dependent upon primary injuries by insects. Damage to telephone and telegraph poles, mine props, posts, and railroad timbers is becoming more noticeable and is causing greater loss on account of the increasing values.

An interesting form of insect damage to forest interests is coming to the front in the way of damage by insects to the cones and seeds of pine, Douglas fir, and balsam fir. Investigations in California have shown that this damage amounted to from 25 to 90 per cent of the available supply. In one locality the forest officials planned to collect 1,000 pounds of yellow-pine seed, but it was found that 90 per cent of the cones were infested by a seed-destroying caterpillar, and the work was abandoned. It was also found that the sugar-pine cones in two National Forests were damaged by a scolytid beetle, and it was estimated that from 25 to 35 per cent of the cones were destroyed.

FIELD DEMONSTRATIONS IN PREVENTION AND CONTROL.

With the increased appropriations made for this section of the work of the bureau for the fiscal year 1911–12, it was possible for the first time to thoroughly systematize the work of field demonstrations and to carry them on with a greater measure of success. The main feature of the field work during the year has been to carry on field demonstrations in the practical application of the recommended methods of preventing or controlling damage by Dendroctonus beetles on living pine, spruce, Douglas fir, and larch. Nine forest insect field stations have been established and at each of these stations work has been conducted under the direct supervision of an entomological assistant who is helped by especially trained agents. Briefly summarized, these stations have begun their work in the following way:

Station No. 1 is located at Columbia Falls, Mont., and covers an area including the States of Montana, North Dakota, South Dakota, Nebraska, Kansas, and Colorado, and parts of Wyoming, Idaho, and Washington. The work at this station during the year included investigations, instructions, and demonstrations on private, State, and Federal lands, involving more than 60,000 infested trees. The principal demonstration project was located in the Tongue River Indian Reservation. In the spring of 1911 it was shown that there was an extensive outbreak of the Black Hills beetle, the timber killed being estimated at about 3,000,000 board feet. Cooperative work was carried on with the Bureau of Indian Affairs of the Department of the Interior, that office having allotted $11,000 for this purpose. About 6,000 trees have been cut and barked and much of the infested timber is being converted into lumber which yields a clear stumpage value of $6, which will go far toward covering the cost of the operations. The work will probably be brought to a successful termination by the end of July, 1912, and the threatened destruction of a vast amount of timber will have been stopped.

Another project under this station is at Swan Lake, Mont., and includes private, State, and National forest timber. About 45,000 trees had died or were infested by the mountain pine beetle. A special arrangement was made between the Forest Service, the State officials, and the private owners, and control work was begun about the middle of February, 1912, under the advice and instructions of a representative of this bureau. The sum of $6,350 was allotted by the three interests involved, and about 30,000 trees have been marked for felling.

Other work has been done by this station at various points in the territory included in its operations.

Station No. 5 is located at Yreka, Cal., and its work covers an area including California, Arizona, New Mexico, and a small section of western Nevada. Two important projects are under way. One is located on Moffit Creek, on private lands, where the owners have paid the expense of operations under the direct supervision of a representative of the bureau. The other project, designated as the Craggy Mountain project, covered both National Forest and private lands to an extent of 15,000 acres. Here 927 large trees were treated at a cost of about $3,000, the cost being met by the Forest Service. Prior to this time a reconnaisance made by forest officials indicated that during a period of 30 years previously the accumulation of insect-killed timber had amounted to from one-fourth to one-half of the total stand, and it was found that the same condition is common in the forests of California and Oregon. It is prophesied that the work carried on under this project will be an effective demonstration to individual owners and to States that this injurious work of the beetles can be stopped at a minimum of expense.

Station No. 6 is located at Klamath Falls, Oreg., and covers Oregon, Utah, the greater parts of Nevada and Washington, the south half of Idaho, and a small section of western Wyoming. The main demonstration project undertaken by this station was on 8,800 acres, the property of several private owners, in the vicinity of Parkers Station, Oreg., where there was a heavy infestation by the western pine beetle and a lesser one by the mountain pine beetle which indicated widespread depredations in the immediate future. The trees requiring treatment were very large, the sugar pine averaging 33 inches diameter breast high and the yellow pine 22½ inches diameter breast high. In all 300 trees, containing a total of 538,000 board feet, were treated at an expense of less than $2 a tree. The low cost of this demonstration should serve as an object lesson and will doubtless do much to bring about that spirit of cooperation among timber owners which the bureau is trying to arouse.

Work on the Whitman National Forest, coming under the work of this station, was terminated June 30, 1911, but the months of July, August, and September were devoted to a complete study of the area worked over, as well as to adjoining untreated areas, to secure data on which to base conclusions as to the results of this work.

Station No. 7 has been located at Spartanburg, S. C., and its work covers an area including North Carolina, South Carolina, Georgia. Florida, Alabama, Mississippi, Louisiana, and Texas. Since great damage was threatened by the southern pine beetle in these States, as referred to in the last annual report, the necessity for concerted action by owners of pine in these States during the fall and winter of 1911–12 was perfectly obvious. This station was started in consequence, and every effort was made to stir up an interest in the subject among the owners of the trees. The southern press assisted actively; addresses were made by experts throughout the infested region; placards were posted in the post offices, and field demonstrations were carried on. There was a general awakening as to the danger and active cooperation was aroused not only among the holders of large tracts of timber but by the thousands of small woodlot owners, and control methods were put into actual practice. An examination made during May, 1912, of the districts where the southern pine beetle was most prevalent shows without question that the ravages of the southern pine beetle have been effectually checked and possibly completely ended for the time being. This is a somewhat remarkable and very gratifying achievement, but a still more gratifying result of this widespread dissemination of information on this subject is that the owners of pine in this region seem to have become so familiar with the methods of control that these methods are likely to be a matter of general routine in the management of timber and recognized as a necessity, just as diversity in crops and the fertilization of agricultural lands are recognized. The actual amount of infested pine cut and treated during the past winter can never be definitely determined, but the evidence furnished by the stumps of the trees and by general information from owners of the timber in parts of the South where the damage had been greatest indicate that an enormous amount of infested pine has been cut. A further indication is the fact that so much cordwood has been offered in the open market in many localities as to lower the price much below that of previous years.

It may be worth while to mention one notable example of successful control at direct expense. This was a 90,000-acre tract, partly in South Carolina and partly in North Carolina. On this property there were thousands of dollars' worth of beetle-killed timber, and there was every indication that the damage would be even greater this year. Sixty infested patches of timber, ranging from 3 to 300 trees, were cut and burned on the ground during the winter of 1911 at a direct cost of $373. Reports from this tract in the spring of 1912 indicate that almost no pine is dying.

SPECIAL RESULTS.

Among the special results of the work of the year are the successful demonstrations to representatives of timber lands and to some of the State and Federal officials that the control of the Dendroctonus beetles in the pine forests of the West and South is not only possible, but that protection of standing timber from insect damage is just as necessary as protection from forest fires, and that such work is directly in line with profitable business methods. The continued healthy condition of the timber in all of the areas where successful control work was carried on, as mentioned in former reports, serves as the most convincing evidence of the practicability of preventing an enormous waste of forest resources.

Conclusive results of the demonstration control work of the last fiscal year will not be entirely evident until July of the present year (this report being written on the closing days of June), but preliminary reports on the thorough examination that is now being made of the several treated and adjacent untreated areas show not only that the control measures have resulted in a direct saving of timber on the areas treated, but that the results have been so obvious that the public in general will undoubtedly apply control measures in other localities.

The results of the active work carried on in the South during the summer of 1911 are among the most important achievements of this branch of the bureau. They are shown, (1) in a greater interest in the subject of protecting pine of the farmers' wood lots and the turpentine and timber forests from the ravages of the southern pine beetle; (2) in the fact that an enormous amount of beetle-infested timber was cut into cordwood by farmers and owners of timberlands during the fall and winter in strict accordance with the instructions given in Farmers' Bulletin No. 476, prepared in this office; and (3) in the evidently complete control of the depredations in the sections in North Carolina and Georgia where the greatest damage was done by the southern pine beetle during the summer and fall of 1911, involving the death of many millions of cords of timber of different sizes.

Cooperation with the Forest Service has been continued and has resulted in the adoption by that service of a definite insect-control policy for the National Forests based on the results of investigations and recommendations of representatives of the Bureau of Entomology. Further cooperation has been carried on with the Indian Office of the Interior Department, and with private owners in South Carolina, North Carolina, and other Southern States, in California, and in Oregon.

Especial investigations in addition to the demonstration work have been under way, and many species have been studied.

INVESTIGATIONS OF INSECTS DAMAGING DECIDUOUS FRUIT TREES.

Investigations of insects injurious to deciduous fruits, vineyards, and nuts have been carried on as heretofore under the direction of Mr. A. L. Quaintance. Some of the projects under way at the close of the last fiscal year have been continued and enlarged, and additional ones have been undertaken.

THE PEAR THRIPS.

Studies of the life history and habits of the pear thrips in California have been continued at the bureau's laboratory at San Jose, and additional important information obtained. Each season presents variations in the behavior of this insect in orchards, especially in regard to the time of its appearance on trees in the spring and the relative number present at a given time. These variations must be carefully considered in order to accomplish effective remedial work, and considerable attention has therefore been given to determining the relation of temperature and rainfall to thrips emergence.

In orchards large-scale spraying operations have been conducted. Three years ago certain orchards were selected in the Santa Clara Valley in which to carry out for several successive seasons the recommendations of the bureau as to spraying, cultivation, and other orchard treatments relating to thrips control. This work has been quite successful, and has served as object lessons to the fruit growers. During the spring of 1912 five of the bureau's agents in California were assigned to the thrips work and were located at different points in the infested territory in a way to give the largest amount of assistance to orchardists in the preparation and application of sprays. A large amount of spraying for the thrips was thus accomplished under the direct supervision of the bureau, aggregating from 10,000 to 15,000 acres of orchards. The results indicate that this work has been quite successful, and a large crop of fruit, it is expected, will be harvested from the treated orchards. On the other hand, orchards not sprayed are represented to have very little, if any, fruit on account of the ravages of the thrips.

In California the insect has not notably extended its range beyond the general territory infested. It is, however, appearing in orchards within this territory in which it was previously not known, and it will soon doubtless be uniformly distributed throughout the deciduous fruit-growing area in the San Francisco Bay region.

Unfortunately, the pear thrips has made its appearance in other parts of the country, as in the Hudson River Valley in New York State, where it was found by the Geneva Agricultural Experiment Station in the neighborhood of Germantown doing injury to pears. The same institution has also determined that the insect occurs in orchards at Geneva, N. Y., and the pear thrips has been discovered by the Bureau of Entomology in several orchards in the vicinity of North East, Pa. Its spread and injuries will be watched with care.

GRAPE PHYLLOXERA.

Satisfactory progress has been made in the investigations in California of the grape Phylloxera. The life-history studies in progress in the laboratory at Walnut Creek, headquarters for the work, have thrown light on several points in the biology of the insect, and some of these have already been verified under vineyard conditions. Thus it has been definitely determined that the winged migrant form of this plant louse is developed in numbers under California conditions, a fact heretofore disputed, which has an important bearing on its dissemination in vineyards. The winged adults have frequently been reared in the laboratory, and the nymphal stage of the winged form has been taken in vineyards and subsequently reared to adult in confinement.

In the field investigations have been carried out principally along two lines, namely, (1) the collection of information on the history of the Phylloxera in the State and its injuries and spread in the vineyards, and (2) the determination of the relative resistance to the insect of roots of different varieties of grapes, the latter work in cooperation with the Bureau of Plant Industry of this department.

Under the first heading the inquiry relates to damage done by the Phylloxera alone to vineyards and damage resulting from the combined influence of the Phylloxera and other causes, as improper drainage; the relative freedom from Phylloxera of vineyards grown on various roots; and the effect on Phylloxera abundance and injury of different cultural methods.

In the determination of the relative resistance to the insect of the roots of various varieties of grapes, plants are grown in the nursery and also in pots. The pot work permits of more accurate observations of the condition of the vines and of the insects than with plants grown under out-of-doors conditions, and is a valuable check on the latter. Comparative studies are in progress on the root galls produced by the insect on varieties of grapes showing varying degrees of resistance to determine if possible the reasons for the comparatively less injury to some sorts than others.

WOOLLY APPLE APHIS.

The woolly apple aphis has long been complained of by orchardists, but its injuries during recent years have apparently been on the increase. As a result, there have been frequent requests for more effective treatments than those commonly recommended against it. The investigation of this insect already under way has been materially strengthened and includes a thorough life-history study of the insect at the Vienna (Va.) laboratory and tests of a large series of substances likely to possess value in its control, both in nurseries and orchards.

While nurserymen and orchardists of certain other countries have for many years made use, in their propagation work, of the roots of varieties of apples resistant to the aphis, American nurserymen, with one or two exceptions, have given little if any attention to this subject. There appears to be no question whatever that injuries from this pest to the roots of apple trees may be avoided by the employment of the roots of certain varieties of apple in a way similar to that which is followed in the case of the grape Phylloxera. Especial attention, therefore, is being given to determine the relative degree of resistance to aphis attack of the roots of our principal commercial as well as other varieties of apple. A collection of apple grafts and seeds has been planted, and the plants when ready for distribution will be tested as to aphis resistance in different parts of the country.

THE CODLING MOTH.

Studies of the codling moth which have been under way during the past several years in different fruit sections representing different climatic conditions are being continued. The life-history studies in progress in Michigan during 1911, as mentioned in a former report, were completed at the close of that year, and a report on the work is now in press. Also the life-history investigations which have been in progress in the Santa Clara Valley in California have been completed and a full report on the subject has been submitted for publication. The bureau has received considerable complaint from apple growers in portions of New Mexico, and in other southwestern States, of their inability satisfactorily to control the codling moth on apples and pears by the methods found effective in the East. Beginning with the spring of 1912 it was found practicable to establish a laboratory at Roswell, N. Mex., to which is tributary a large fruit-growing interest. Careful attention is there being given to observations on the habits of the codling moth, and large-scale spraying experiments are in progress in orchards to determine the proper schedule of applications to be followed under the conditions there existing.

The tests in progress during the fiscal year 1910–11 of the so-called one-spray method in comparison with the usual schedule of treatment followed in the East were concluded at the close of the growing season of 1911, and a full report on the subject is now in the course of publication. It was determined that a high degree of efficiency in the control of the codling moth and plum curculio was obtained from a single application of spray made immediately after the falling of the petals. In the case of varieties of the apple little subject to fungous diseases, the one-spray method would appear to be of much value under eastern conditions. The investigation further developed the very important point of the necessity for greater thoroughness in spraying at the time of the falling of the petals than has generally been followed by orchardists.

Owing to the prevailing differences of opinion between certain eastern and the western entomologists in regard to the condition at spraying time of the structures at the calyx end of the apple, a careful inquiry has been begun in Michigan and New Mexico, representing humid and arid conditions, respectively, to determine the condition for many varieties of apple of the so-called calyx cup during the two or three weeks subsequent to the falling of the petals. This information will have a distinct bearing on the character of spraying to be done to best insure poisoning the calyx cup, the prime essential in codling-moth control.

Demonstration spraying for the codling moth, as in former years, is being carried out in connection with other work in some of the bureau's field stations, notably in Michigan, New Mexico, and, during 1911, in Delaware. This work has been much appreciated by orchardists in the neighborhoods where located and has resulted in a distinct improvement in the character of work done by them in their own orchards.

The investigations of the codling moth throughout the Appalachian Mountain region, begun in the spring of 1911, are being continued. Last season's work indicated the importance of a thorough knowledge of the insect throughout this region, due to the variation in its behavior under the different conditions of altitude in which apples are grown. Band records and life-history observations are being made at 10 or 12 different stations located at representative points in western Maryland, Virginia, and West Virginia.

THE GRAPE LEAFHOPPER.

The grape leafhopper has during recent years become very troublesome in vineyards in the Lake Erie Valley, and special effort has been made to perfect a treatment for its control. The spraying experiments and demonstrations carried out in vineyards in 1911 have shown conclusively that great benefit may be obtained by the proper use of nicotine sprays directed against the immature stages or nymphs of this insect. This work, however, has shown the necessity of a more detailed knowledge of the life history of the pest, especially as to the period over which the insect in the immature stages will be found on the vines, and the present season's work will be devoted largely to questions in its life history as contributing to a more effective spraying schedule. A report has been prepared and submitted for publication, dealing with the results of field experiments carried out during the growing season of 1911.

OTHER INSECTS.

Studies of the grape berry moth, which have been in progress for several seasons, have been practically concluded and a full report on the subject is now in press. Work against the fruit-tree leaf-roller has been carried on, with headquarters at Canyon City, Colo., where the pest is especially troublesome. An experimental orchard has been planted for the study of apple-tree borers in a region where these insects are abundant. Considerable work has been done with the parasitic and predatory enemies of deciduous fruit pests. The peach bud mite and the peach Lecanium have been subject to especial study, and some careful work has been done with the most economical and effective insecticidal sprays.

CEREAL AND FORAGE-PLANT INSECT INVESTIGATIONS.

The work of the section of cereal and forage-plant insects, carried on under the immediate supervision of Prof. F. M. Webster, was enlarged in its possibilities by the appropriation of additional funds, largely owing to the urgent need for extensive work against the alfalfa weevil, and several other problems of economic importance have come up in the course of the general work of the section.

THE ALFALFA WEEVIL.

Owing to the appropriation of additional funds, the work against the alfalfa weevil has been carried on much more extensively than has been possible heretofore. Additional men have been added to the force of investigators, and the insect has been carefully followed through the entire year and through its annual life cycle. Not only has this work been carried on in the laboratory and in the fields adjoining headquarters, which are at Murray, Utah, a short distance south of Salt Lake City, but they have been duplicated to a large extent in higher altitudes, in order to obtain a thorough knowledge of the insect throughout the territory over which it has become distributed.

Much experimental work has been carried on in the fields, both with parasitic insects and with parasitic fungi. Other experiments have been conducted with reference to the treatment of the infested fields by different cultural methods, including irrigation. Still other experiments have been carried on, in cooperation with the Bureau of Plant Industry, with reference to the determination of a possible partial immunity in certain strains of alfalfa. In cooperation with the Utah experiment station, field experiments have been carried out in the way of combining alfalfa with other crops in order to reduce, if possible, the intensity of the weevil attack. There seems to be a disinclination on the part of the weevil to work in shaded places, and experiments are being carried on in growing alfalfa mixed with grains and grasses in order to determine if a mixed crop of hay can not be obtained, the value of which will be equal to that of clear alfalfa, and thus evade some part of the weevil damage.

Very good results have been obtained by the use of a modified cultivator, in which the shovels of the cultivator are displaced by steel-wire brushes, and also by attaching these brushes to a spring-tooth harrow.

Good results have also been obtained by flooding the infested field immediately after the removal of the first crop of hay and then, while some of the water is still standing on the field, dragging a heavy plank drag over the surface. This process has come to be known as the "mudding process."

Many other experiments have been undertaken and are being tested, but at this time it is too early to express an opinion as to their value. The State experiment station, the people, and the railways have cooperated most heartily and have greatly facilitated the work. While it has not been possible to stamp out the pest at any one point, there seems to be a good prospect that growers will be able to control the insect to the point where they can still produce profitable crops. The results of the investigation carried on down to the close of 1911 are embodied in Bulletin 112 of the Bureau of Entomology.

THE SO-CALLED GREEN BUG.

The work on the so-called green bug has been practically completed and Bulletin 110 of the Bureau of Entomology, treating of the pest, is now in press. Nothing further remains except to keep the entire southern country under continual surveillance in order that farmers may be warned of impending danger and to carry out such other investigations as may be made necessary by changing agricultural conditions or farm operations.

HESSIAN FLY INVESTIGATIONS.

The Hessian fly investigations have been continued both in the eastern and western portions of the country, and humidity experiments are being carried out in the West. This latter work will of necessity cover a number of years. The progress so far made, however, indicates that wheat grown under dry-land farming may wholly escape attack from this pest.

THE SOUTHERN CORN ROOT-WORM.

Field studies of the southern corn root-worm have been carried on at several points in the southern part of the country and our knowledge of its life history is nearly complete. It is intended to carry on a series of field experiments over a large range of country in the Southern States to determine the possibility of evading the ravages of the insect by planting corn at certain later dates than those now commonly used throughout the Southern States. A large amount of data has been accumulated to indicate that protection from the ravages of this insect may lie in this direction.

THE SOUTHERN CORN LEAF-BEETLE.

The southern corn leaf-beetle appears occasionally and destroys a great deal of corn over large local areas and it has been investigated for several years. There are two or three points of vital economic importance that are still lacking in order to make the information obtained available for the protection of the farmers' crops. The entire life history of the insect from egg to adult has been carefully worked out, but additional information with reference to its food plants is yet to be secured.

THE WESTERN CORN ROOT-WORM.

An apparently unusual and certainly unexpected outbreak of the western corn root-worm has been in progress in Tennessee. A complete life history of the insect is being worked out and additional knowledge of its habits obtained which will undoubtedly enable us to suggest thoroughly effective and practical methods of prevention under a greater variety of cultural conditions than heretofore. It is hoped that this investigation will be completed during the coming fiscal year.

THE NEW MEXICO RANGE CATERPILLAR.

The country over which the New Mexico range caterpillar is known to occur has been gone over carefully, and, owing to adverse weather, the species was not so destructive during the year as it was earlier. The indications are, however, that as soon as it recovers from the backset occasioned by adverse weather conditions it will be as destructive over a widened range of distribution as it was two years ago over a more limited area.

OTHER FIELD INSECTS.

The long-continued investigation of leafhoppers with relation to cereal and forage crops throughout the United States has been completed and a bulletin (No. 108) giving the results of this investigation is now in press. Similarly an investigation of two species of false wireworms injurious to growing grain in the extreme northwestern portion of the country has been completed and the results published. One of the corn billbugs, very destructive to corn in some portions of the country, has been studied, and entirely practical measures for preventing further injuries have been found, an account of which has been published. A thorough study of a chinch-bug outbreak west of the Mississippi River has been carried out, and the results of the investigation, including practical measures of prevention, have been published. Another completed investigation is that of the western army worm and its damage to wheat and alfalfa. The jointworm work and the white-grub investigations have been continued, and the latter have been extended over a much wider range of country, including the States of South Dakota, Wisconsin, Kansas, Indiana, Ohio, Virginia, and Pennsylvania. Wireworms, the corn leaf-aphis, the western grass-stem sawfly, the clover stem-borer, a new plant louse on alfalfa, and a leaf miner damaging the same plant, a gall midge on alfalfa, and a clover and alfalfa seed chalcis have all been studied with favorable results.

A number of other insects that each year seem to be increasing on alfalfa and other crops grown in extreme southern Texas demand attention. Some of these are entirely new in the United States, having spread northward from across the Rio Grande. One of these is the Mexican army worm; another is a new root-worm, which, however, has not yet become seriously abundant. There are also several species of thrips, as well as an undescribed mite, which attack alfalfa, and another mite attacks barley in Arizona. Upon all of these species studies have been begun.

WORK ON INSECTS AFFECTING VEGETABLE CROPS.

The work on insects injurious to vegetable crops, which includes truck crops and some of the smaller berries, and some other work which can not otherwise be classified, such as the investigation of hop insects, has been carried on under the direct supervision of Dr. F. H. Chittenden, as in previous years. Several stations, established at first in a tentative way, are now nearly under full swing, as follows: In tidewater Virginia, where general work has been done for several years; in southern Texas, where a somewhat different line of work has been carried on; in southern California; at Rockyford, Colo.; in Indiana; on Long Island, and in Maryland. The life histories and habits of quite a number of species not hitherto investigated have been nearly completed, and some insects comparatively new as pests have been studied. New insecticides, especially in combination with others, have been tested at all the stations, and some eminent successes have been achieved in demonstration.

INVESTIGATIONS IN TIDEWATER VIRGINIA.

Series of arsenical spraying tests against the Colorado potato beetle in tidewater Virginia, begun toward the end of the last fiscal year, have been continued with different strengths of arsenite of zinc in comparison with arsenate of lead and Paris green and in combination with or in comparison with Bordeaux mixture, lime-sulphur, and other sprays. The results will be available when the potato crop is dug.

While observations were being continued on the seed-corn maggot, a general pest in vegetable fields, a field comparatively free from these insects became seriously infested after the application of fish scrap or tankage. This attracted the flies, which laid their eggs, and the field was soon found alive with maggots. This fish scrap is much used in tidewater Virginia, both as a fertilizer and as an insect deterrent, but it is obvious that in this case at least its use was detrimental rather than beneficial.

Lady-beetles obtained from California were liberated in the vicinity of Norfolk and Portsmouth, Va., to the number of more than 100,000.

Experiments against Fuller's rose beetle were carried on at this station, but nothing more efficient than hand picking was found.

INVESTIGATIONS IN TEXAS.

While many of the truck-crop insects have been studied in Texas, and reports upon them will soon be available, the onion thrips, as during the previous year, was the principal project. Damage by this insect during 1911 was very considerable, but it has not been so pronounced during the first part of 1912. Clean cultivation has been practiced with favorable results, and the spraying solutions which have turned out to be the best are nicotine solutions with whale-oil soap, strong turpentine soap, lysol, and lime-sulphur. Kerosene emulsion was used to some extent, but owing to the amount of lime in the water it was difficult to secure a stable emulsion. The main object of this investigation has been to find some means of holding the thrips in check so that the plants may mature normal bulbs. Many growers have sprayed too late, not beginning until after the plants have begun to curl. After such a check in growth has gone on for several weeks spraying is practically useless, unless excessive rains occur, in which case possibly one-third of the crop will mature to a normal degree. Some of the growers have succeeded in holding the thrips in check with only two sprayings, while others have had to spray as many as seven times. It is hoped that the next season's work will result in a lessening of the number of applications needed and in the use of machines that will cover more than one row at a time. It is estimated that 25 per cent of the onion crop in Texas was lost through the work of this insect during the season of 1910–11.

INVESTIGATIONS IN SOUTHERN CALIFORNIA.

A laboratory for the study of truck insects has been maintained at Compton, Cal., and much new information has been gathered concerning the insects affecting truck crops and sugar beets. The bean thrips, among others, has been carefully studied, and its habits, life history, and control have been fully worked out. An interesting internal parasite has been found which is also parasitic on the onion thrips, the percentage of parasitism often reaching 30 to 50 per cent. It has been demonstrated that this parasite can be successfully transported elsewhere by shipping the dormant parasitic pupæ. Attempts are being made to introduce it into other sections of the United States in which the onion thrips is causing damage.

Cutworms and wireworms infesting sugar beet have been carefully studied and an investigation of the beet root-aphis has been continued.

Work on the celery leaf-tyer has been nearly completed, and it has been shown by chemical analyses of sprayed celery that there is no danger to the consumer from celery sprayed with arsenicals.

INVESTIGATIONS IN NORTHERN CALIFORNIA.

With headquarters at Sacramento, Cal., investigations were conducted upon the red spider of the hop, the hop aphis, cutworms, and the white ants attacking trellis poles.

A good means of fighting the so-called red spider has been worked out. This consists of mixing lime-sulphur with flour paste, afterwards diluting it. This mixture kills the eggs of the mites, whereas powdered sulphur did not have this effect. Two applications were necessary thoroughly to reduce the infestation.

Observations were made upon the hop aphis at Santa Rosa, with especial reference to its hibernation, and spraying experiments were carried on to determine the efficiency of various proportions of nicotine sulphate and whale-oil soap, blackleaf tobacco with whale-oil soap, and whale-oil soap alone.

WORK IN INDIANA.

Investigation of the onion thrips, which down to the present year had been largely carried on in the onion-growing regions of California and Texas, has been continued in a new locality and under somewhat different conditions. In the vicinity of Knox, Ind., where the soil is of a peaty nature and is well underlaid with sheet water, a large industry has grown up, the onion acreage in 1910 approximating 1,500 acres, while in 1911 it was practically doubled. The climatic and soil conditions obviously differ widely from those in the semiarid irrigated regions previously experimented with, and it has been found that somewhat different methods are productive of the best results in the control of the thrips. The damage during 1911 was conservatively estimated at more than $100,000, an average loss of $36 per acre. Extensive cooperation must be secured for the control of the insect in this region. Proper cultivation must be carried on at the right time, and control measures must be begun before serious injury occurs. New experiments are being made, and special adjustments in types of sprayers are being tested which will no doubt demonstrate some effective control measures.

Other investigations that have been carried on in this locality concern the life histories and control of a number of other pests at present injurious to the onion in the Indiana section. Demonstrations have been conducted in the practical application of cutworm and wireworm remedies. All other insects of interest to the truck grower have been under observation in order that appropriate remedies may be prescribed at short notice.

WORK IN COLORADO.

The most conspicuous insect outbreaks of the year at the station in Colorado were occasioned by grasshoppers and by the beet army worm. Grasshoppers occurred by millions throughout the valley, and caused extensive damage to sugar beets and truck crops. Where it was possible to stir farmers into action the hoppers were controlled. The so-called Criddle mixture, successfully used elsewhere, proved here an almost complete failure. Bran and arsenic bait and the use of hopperdozers gave excellent results, while spraying gave more satisfactory results than any other method. The sugar-beet webworm infested an area of nearly 1,000 acres of beets in the Arkansas Valley alone. More than 200 acres were successfully sprayed at Rocky Ford, and it was demonstrated that the sugar-beet webworm and the beet army worm can be readily controlled by spraying with Paris green and whale-oil soap. The unexpected discovery was made that Paris green is more satisfactory for use on beets than arsenate of lead. Much work was done at this station upon a number of garden pests, especially as to life histories.

INVESTIGATIONS ON LONG ISLAND.

Work upon the potato flea-beetle and upon various cauliflower insects was taken up at the Long Island station. Spraying experiments with arsenite of zinc, arsenate of lead, Paris green, and a combination of arsenite of zinc and atomic sulphur were made against the cabbage looper on cauliflower. It was found that it was necessary to use some sticky substance in order to make the spray adhere to the waxy leaves of the cauliflower.

WORK ON INSECTS AFFECTING CITRUS FRUITS.

The investigation of the insect enemies of citrus and other subtropical fruits has been carried on during the past year as heretofore under the direct supervision of the Assistant Entomologist, Mr. C. L. Marlatt. The leading projects have been the investigation of the orange thrips in California and the white fly in Florida, with the introduction from India of predaceous and parasitic enemies of the last-named insect. This attempt at introducing the natural enemies of the white fly has been referred to in a previous section of this report.

WORK ON THE WHITE FLY IN FLORIDA.

As indicated in the last report, the investigation of the white fly in Florida had made substantial progress and is nearing completion. The finished work included reports on life history, control by hydrocyanic-acid gas and by natural agencies, such as fungous diseases, the destruction of unnecessary food plants, and an attempt in many ways to create conditions favoring immunity from attack by the fly. There remained uncompleted the important means of control by sprays, and work during the last year has been concentrated upon these measures. Inexpensive but effective oil-soap sprays have been worked out and are now being used, and these promise to settle in a satisfactory manner the problem of direct control. There are now in preparation or in print reports covering the completed aspects of this investigation, namely, (1) control by fumigation; (2) control by natural agencies, such as fungous diseases, and (3) control by spraying. The life-history studies have already been published. There is also in preparation a report giving results of the explorations of Mr. Woglum, the expert who was sent to India, including an account of the discovery of the native home and probable original range of the white fly in Asia and the facts found by Mr. Woglum in relation to control by parasites in India and the methods devised for collecting and introducing the natural enemies.

THE ORANGE THRIPS.

The investigation of the orange thrips at Lindsay, Cal., has been continued during the past year along the lines indicated in the last report, and the demonstrational results of the spraying tests have been satisfactory and have resulted in their general adoption by the growers.

For the season of 1912, already begun, there is under way further demonstration spraying of orchards with lime-sulphur at the strength which past work has shown to be most advisable, namely, a stock solution of 36° Baumé diluted for application to the trees with 56 parts of water.

In connection with the thrips work at Lindsay, a number of other troublesome pests of the orange have been investigated, particularly a green katydid and certain leaf-feeding larvæ. Against this class of insects tests have been conducted with arsenicals in combination with the lime-sulphur demonstration for the orange thrips just referred to. The work against the orange thrips in this region and the particular leaf-feeding insects mentioned should be completed with this year's work, and a final report prepared for publication.

INVESTIGATIONS OF INSECTS IN THEIR DIRECT RELATION TO THE HEALTH OF MAN AND DOMESTIC ANIMALS.

THE HOUSE FLY AND THE MALARIAL MOSQUITO.

Some additional experiments have been carried on with regard to the destruction of the disease-bearing house fly, and every effort has been made to stimulate the popular crusade against this insect which has been spreading over the country, and to assist in every possible way those engaged in remedial movements in different cities and elsewhere. The work of the bureau has been a prime factor in the spread of knowledge concerning the carriage of disease by the house fly and of the best measures for its control.

In the same way, by correspondence, by the distribution of printed information, and by further studies, the encouragement of work against the malarial mosquitoes of the genus Anopheles has been fostered during the year as during the previous year. Antimosquito work has been undertaken in many places for the purpose of relieving the annoyance caused by the presence of mosquitoes. It is hoped, however, that movements directed mainly against malaria may be increased in number in this country. It is a strange fact that in other countries antimosquito work has been carried on practically entirely with the idea of reducing the mortality from malaria and the incapacitation of labor from the effects of this disease, while in this country, with the exception of the work done upon Staten Island, all measures against mosquitoes have been inaugurated against them simply as nuisances and as operating to reduce the value of real estate, and not primarily as a means of lessening disease.

WORK ON TICKS.

The tick work done by the bureau has been under the direct supervision of Mr. W. D. Hunter, and includes studies of and experiments with all ticks concerned in the carriage of diseases of animals and man. The investigation of the Rocky Mountain spotted fever tick in the Northwest, referred to in the last report, was carried to the point where it was possible to outline a means of eradication that is both practical and economical. By this plan, resulting from life-history studies, it has become possible to organize a campaign for the total eradication of this important pest at a cost of about $25,000. The details of this plan have been elaborated in a bulletin published by the bureau. Arrangements had been made to continue observations on a small scale to show the longevity of the ticks under different conditions, but the work has been discontinued for the reason that the United States Public Health and Marine-Hospital Service, at the request of the State health authorities of Montana, decided to take up the problem, which more logically belongs to that service than to the Department of Agriculture. In its work the bureau carried on its investigations in cooperation with the State Agricultural Experiment Station of Montana and with the Bureau of Biological Survey of the United States Department of Agriculture.

With the practical completion of the work on the spotted-fever tick, it became possible to devote some attention to other species of considerable economic importance, upon which only general observations had been made. Work was begun on the fowl tick, which is a serious pest in a large area of the southwestern portion of the United States. At the same time the spinose ear tick was taken up. This creature is the cause of the loss of a large number of calves in Texas, New Mexico, and Arizona.

The work on the accumulation of data regarding the life history of the species which transmits splenetic fever of cattle was continued. This consisted largely of experiments to determine the longevity of the different stages of the tick under different environments. This work has been of great practical value in connection with the eradication of the cattle-fever tick in the United States, and it has progressed to the point where it will soon be possible to issue a bulletin on the points in the life history of the species, which must be taken into consideration in the work of eradication that is now under way.

Studies on the life history of a number of species of minor importance were completed and the results placed in the form of a publication. Incidentally observations were made upon several other pests of live stock, including the horn fly and the screw-worm, which will lead to the formation of plans for better control of these species in the future.

INVESTIGATION OF POSSIBLE TRANSMISSION OF PELLAGRA BY INSECTS.

Attention was called in the last report to the announcement by Dr. Sambon that in Europe a species of Simulium is the probable agent in the transmission of pellagra. During the fiscal year, at the request of the State board of health of South Carolina, two agents of the bureau were sent to that State to investigate the subject. They had been occupied in determining the distribution of sand flies with reference to the locality in which pellagra is known to have originated. For various reasons the theory proposed by Dr. Sambon is of doubtful validity. Nevertheless there seem to be indications that the disease may possibly be transmitted by certain insects if not by sand flies. For this reason the investigations of the bureau have dealt with a number of species of biting insects which are to be found commonly in localities where pellagra occurs. Much material was collected, but down to the present time there are no definite indications that pellagra is an insect-borne disease. It is, however, necessary to do much more work before any reliable conclusions can be reached.

WORK ON INSECTS INJURIOUS TO STORED PRODUCTS.

Work on insects injurious to stored products has been performed, as previously, under the immediate direction of Dr. F. H. Chittenden. Many practical tests have been made of the value of bisulphid of carbon and hydrocyanic-acid gas.

Of especial interest was the work on the fig moth conducted last year and published in November, 1912. Investigations of the life history, habits, and control of this species in California have been continued.

Some important experiments have been carried on with carbon tetrachlorid as a substitute for carbon bisulphid in fumigating for insects. It has been shown, after numerous experiments under different conditions, that this substance can not be economically applied on a large scale, but may be used to advantage for choice seeds and in office rooms and dwellings. Where rooms can be made air-tight and where the use of inflammable materials like carbon bisulphid are prohibited or are undesirable, this substance could be used very generally, since it is not dangerous to man in any way. Its expense, however, is such as to prevent its very general use. It would, in fact, be an ideal fumigant under these conditions were it not that it costs three times as much as bisulphid of carbon.

The broad-bean weevil has become established in California and in the East, and is spreading. Its distribution in the United States and abroad and its supposedly poisonous nature have been investigated, and germination tests of infested seeds have been made and much experimental work has been done with remedies. It seems that there is a possibility of the eradication of the species by cooperation in California or by special legislation, by insisting on the practice of holding seeds over for two years and by the fumigation of all beans arriving on the Atlantic coast.

Investigations have been conducted on other species affecting beans, peas, and cowpeas and similar seeds in storage. Some of these are new, some have been introduced, and some are native to the United States.

Experiments have been carried on in the fumigation of rice mills. Some firms use with success a combination of sulphur and lime. The use of naphthaline as a preventive and of some adhesive substance which will kill insects in the floors and then dry have been continued.

INSPECTION WORK.

As previously indicated, the principal inspection work done by this bureau relates to the examination of the seeds, plants, and fruits imported by the Department of Agriculture, and of commercial importations consigned to dealers in Washington direct or in bond. No less than 1,039 lots of seeds and plants imported by this department have been carefully inspected—sometimes twice, once on receipt by the department and again before distribution. Many of these lots have been held in quarantine, and to safeguard against the introduction of dangerous insects a number of them have been destroyed. The bureau was advised of some 60 commercial importations during the year, and these were inspected. There was also a shipment of about 3,000 ornamental flowering cherry trees, sent as a gift to this city from the city of Tokyo. These trees were examined individually with great care and were found to be in perfectly healthy condition as regards insect attack.

It has been necessary also, as in the past, to inspect all local living plant stock shipped from the District, inasmuch as there is no other means for such inspection, and the laws of surrounding States require inspection and certificate as a condition of entry.

Many of the foreign insect pests detected by such inspection are already established in this country, but their discovery on these new importations illustrates well the probability of their original entry. Many others have been insect pests new to this country. Among the latter are a number of scale insects from China, which, if allowed to escape and to become established, might be just as destructive as the notorious San Jose scale, which is also of Chinese origin. Some plants from Italy brought another scale insect unknown in this country, but which in Italy is a distinct pest. Walnut scions from Tientsin, China, were found to contain the eggs of an insect just ready to hatch. This insect is the one referred to as having been found on cuttings from China last year, and, judging from our knowledge of allied insects, would probably be a serious tree pest if established. A new mango-seed weevil was found infesting mango seeds from India, and another weevil was found infesting the seeds of the avocado. Other imported mango seeds were found to be infested with a new lepidopterous borer, and the common mango weevil referred to in last year's report was also frequently found in imported mango seeds. Imported date palms from Egypt were practically always infested with the two important date scales which, unfortunately, have already gained a foothold in most of the date orchards in this country. The greatest care should be taken, however, to prevent entry of these scales into new date plantations which may be established.

THE PRESENT STATUS OF THE PROPOSED PLANT-QUARANTINE LAW.

The effort to secure an adequate plant-quarantine law to protect this country from the entry of new insect pests or plant diseases with imported nursery stock or other living plant material has been referred to somewhat at length in previous annual reports. The new bill referred to in the report for last year was introduced at the extra session of the present Congress, but there was no opportunity to advance it at that session.

In December, 1911, this measure was carefully considered by a well-attended meeting in Washington, at which many of the States were represented through their State or experiment-station entomologists, horticultural inspectors, or other horticultural officers. The meeting was also attended by representatives of the nurserymen. An agreement as to certain modifications of the measure was reached, which resulted in the approval of the measure by the nurserymen who had before opposed it on the ground that it might be prejudicial to their importing interests. The bill as thus modified was introduced at the present session of Congress and given a hearing before the agricultural committee of the House. As a result of this hearing the bill was still further modified, and these modifications were accepted by nurserymen and seedsmen and approved by this department and the State officials concerned. The bill thus revised (H. R. 24119; Rept. 660) was unanimously reported from the Committee on Agriculture and is now awaiting its turn for attention in the House.[1]

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[1] Since the above was written an act "to regulate the importation of nursery stock and other plants and plant products; to enable the Secretary of Agriculture to establish and maintain quarantine districts for plant diseases and insect pests; to permit and regulate the movement of fruits, plants, and vegetables therefrom, and for other purposes," was approved August 20, 1912.

In general, the Federal powers granted in this bill relate to the establishment, when desirable, of foreign and domestic quarantine; the issuance of permits for importations; the requirement of foreign certification as to freedom from disease or insect infestation; and the distribution to the several State officials by the Department of Agriculture of exact information in regard to origin and arrival and destination of all importations. To the inspectors of the several States is left the responsibility for inspection and disinfection of imported stock and the cleaning up and disinfection of local quarantined districts.

Under this bill as much protection can be had as would come from any legislation providing for inspection at point of destination. It will enable quarantine to be declared against such immediate dangers as the Mediterranean fruit-fly, the potato-wart disease, and the white-pine blister rust. The last two dangers were referred to in some detail in my last annual report. The Mediterranean fruit-fly is a new risk and a most serious one. This insect, which has a long record of excessive damage to all sorts of fruits and vegetables in a good many foreign countries, has recently become established in the Hawaiian Islands and unless quarantined against is certain to be brought in from those islands or from other quarters of the world where it has gained a foothold. It is, perhaps, a more serious fruit pest than any now occurring on this continent. Its larvæ, or maggots, infest all sorts of fruits and many vegetables, and the presence of these in fruit can not be determined except by cutting the fruit open, unless the destruction has gone to such a stage that putrefaction has set in. Its introduction would be most disastrous to the citrus and deciduous fruit interests of the southern Pacific coast and throughout our Southern States. It is a grave danger not only to all subtropical fruits and vegetables, but to peaches and melons and other similar crops now grown most profitably over a large section of the South.

The imminence of this danger has already led Congress to make an appropriation of $35,000 to be expended in an attempt to control this fly in the Hawaiian Islands, and thus limit to some extent the likelihood of its reaching the United States through California. Its extermination in the Hawaiian Islands is recognized as absolutely out of the question, and the only effective safeguard is a quarantine which will exclude fruits or vegetables likely to carry the insect.

The need, therefore, of a Federal plant-quarantine law is much greater than ever, and delay in securing it may result in enormous and continuing damage to the fruit interests of this country.

In the absence of this legislation this bureau has proceeded along the lines reported in previous years, securing as complete records as possible by voluntary cooperation of railroads and customs officials of imported plant stock and transmitting the information relating to arrival and destination of the imported stock to the proper State officials with the hope that the latter would inspect and safeguard the entry of such goods. As previously pointed out, there is no assurance that the records thus obtained are complete, and there is very great probability that injurious pests which we know are coming in may gain foothold at any time. Importation of cheap and often refuse stock by department and 5-and-10-cent stores has continued, and much of this stock is not inspected at all, or, if inspected, given scant attention.

As the United States is practically the only important country in the world without a rigid inspection and quarantine law, it naturally becomes the recipient of goods of such quality or infestation as can not find a market elsewhere. A notable illustration of this is seen in the potato crop of Newfoundland, which is now known to be more or less infested with the potato-wart disease. Canada has quarantined strictly against Newfoundland's potato crop, which practically diverts this crop to the United States. As an interesting result, Canada has recently amended her quarantine act to include the potato crop of the United States, on account of our receiving, without examination, potatoes from Newfoundland and the consequent risk to Canada of receiving some of these potatoes again from the United States or potatoes infested from this source. The short crop of potatoes of last year had also the unfortunate result of vastly increasing the quantity of potatoes brought in from abroad, and some of this imported stock came from infested districts in Europe. All of it, therefore, is under suspicion. A circular of warning has been issued by the Bureau of Plant Industry in relation to these imported potatoes, urging the farmers not to use such stock for seed, but such warnings will necessarily fail to reach many, and imported diseased potatoes may very probably have been planted. Every year's delay, therefore, adds enormously to the risk we are running, and prompt action by Congress can not be too strongly urged.

WORK IN BEE CULTURE.

The increased appropriation for apicultural investigations has made it possible substantially to increase the work in this direction during the past fiscal year. It has been carried on, as before, under the direction of Dr. E. F. Phillips. The poor season of 1911 and the severe winter of 1911–12 have served greatly to discourage the bee keepers of the country, and the losses have been enormous. In spite of this discouraging combination of circumstances, however, the interest in the industry seems constantly to increase, and there is a steady and encouraging growth in interest in the work of the bureau on this subject.

BEE DISEASES.

The work on the etiology of the brood diseases of bees has been continued, and during the fiscal year the cause of European foul brood has been determined for the first time. This disease, which causes such heavy losses in various parts of the country, is caused by *Bacillus pluton*, an organism discovered and named by Dr. G. F. White, of this bureau. Dr. White now has the credit of having determined the causes of the two serious infectious diseases of the brood—American foul brood and European foul brood. The more recent work is described in Circular No. 157 of this bureau.

The paper summarizing the most important publications on the etiology of bee diseases, which was mentioned in the last annual report, has been issued as Bulletin No. 98. This bulletin should be of great value in aiding investigators and practical bee keepers to judge more accurately the reported results of work on this subject and in clearing up the confusion which has been so widespread among students of bee diseases.

The work on the diseases of adult bees has been instituted, especially in a study of the parasite *Nosema apis*. Information has been obtained concerning its prevalence and distribution. This organism is the one which certain European investigators have studied and which is reported by them to be the cause of certain serious diseases of adult bees. A field study of the condition known as bee paralysis was made early in the spring in apiaries in Florida, where this is reported as causing considerable losses.

The work on the geographical distribution of the two brood diseases—American foul brood and European foul brood—has been continued, and during the fiscal year 1911–12 959 samples were examined, as against 1,054 for the year 1910–11. After the publication of Circular No. 138, giving data up to March 1, 1911, there were received during the season of 1911 samples showing the existence of American foul brood in 116 additional counties and European foul brood in 71 additional counties. At the close of the season of 1911, therefore, the records showed American foul brood in 410 counties in 39 States and European foul brood in 236 counties in 25 States. The work is to be continued during the summer of 1912. So far special attention has been given to the Eastern and Northern States, since the infectious diseases are most abundant there, but in view of the fact that numerous isolated outbreaks are present in other parts of the United States, an attempt is now being made to locate these. Such information will be especially valuable to bee keepers in such States who are interested in urging the passage of laws providing for inspection of apiaries, so that the diseases may be brought under control and the bee keepers educated in their treatment before the situation becomes so bad as that in the older infected areas.

The data obtained in the study of the distribution of the brood diseases have been extensively utilized during the year in an educational campaign. Warning cards were prepared and sent to about 60,000 bee keepers whose names were obtained in counties where disease was known to exist. At the same time press notices were sent out to the weekly newspapers in the same territory, calling attention to the existence of disease and suggesting methods of getting information on the subject. Somewhat similar notices were sent to the agricultural papers. One of the most important features of this work was the insertion of information on brood diseases in the catalogues of various dealers in bee keepers' supplies. This was done at the suggestion of this bureau, and in several cases copy was supplied, as well as cuts illustrating the two diseases. In all, probably nearly a million catalogues were circulated among the bee keepers of the country, calling their attention to the existing conditions and giving directions for obtaining further information and help. The results of these undertakings are being shown clearly in the greatly increased number of special inquiries, requests for bulletins, and samples of suspected brood sent for examination.

A special inquiry into the methods and results of apiary inspection and the cost in various States has brought out some interesting data, which will be incorporated in a bulletin to be issued in connection with the data on the distribution of the brood diseases. The information obtainable is sufficient to indicate a marked benefit from apiary inspection and fully justifies the efforts of this bureau and other agencies to perfect the inspection service. It is conclusively shown that the placing of the apiary inspection under an already existing office, such as that of the State entomologist, leads to economy and greater efficiency. The actual cost per colony varies greatly, due in part to differences in facilities for travel and the state of the bee-keeping industry, but it is clear that a methodical covering of the territory is the greatest factor in successful work. Special attention has been paid to methods of keeping inspection records.

Special assistance has been given the inspectors in New Jersey, Pennsylvania, and Colorado. A 10-day trip through Colorado was taken with the deputy State inspector for the purpose of studying the disease situation in that State.

An important step in the fight against these diseases was the organization of the Association of Apiary Inspectors of the United States and Canada in December, 1911, in Washington, at the call of Dr. E. F. Phillips, of this bureau. The object of this organization is to bring about improvement and uniformity in legislation, inspection, and records. While this is not a bureau movement, it will serve as a valuable adjunct to its activities in these respects. A meeting of the apiary inspectors of the northeastern United States was held at Amherst, Mass., in February, at which Dr. Phillips represented the bureau.

As in the past, information concerning the presence of disease is at once sent to the authorized inspectors of apiaries. Wherever possible, bulletins on the treatment of disease are sent to all known beekeepers in territory found to be infected, and in every way possible an effort is made to help the bee keepers to an understanding of the difficulty.

During the year, at the request of some western bee keepers, a revised regulation was issued by the Post Office Department concerning the mailing of queen bees. This step was taken to prevent the spread of brood diseases through the mailing of queens from infected apiaries. As issued, this would have served practically to destroy the business of queen rearing, and consequently the department recommended a further revision, which was adopted and signed May 3, 1912. As it now stands it meets with the approval of the leading bee keepers of the country and should serve to retard the spread of disease. Too much should not be expected of this precautionary measure, however, as there are still other avenues open for the spread of infectious diseases.

THE DEVELOPMENT OF THE BEE.

The work on the development of the bee, which has been carried on for some time, has been completed, and the results are being incorporated in a manuscript to be presented for publication in the immediate future. The work so far done included the development in the egg up to the time the young larva hatches, and will now be continued to include the anatomy of the larva. This work has been done by Dr. James A. Nelson.

BEHAVIOR OF THE BEE.

As a foundation for work on the behavior of the honey bee, a study of the structure of the sense organs is being made. The results so far indicate a wider distribution of such organs than was previously known and will form a basis for experimental work on the functions of the organs, now under way. Some preliminary experiments were conducted during the summer of 1911. This work is being done by Dr. N. E. McIndoo.

The behavior of bees in wax secretion and comb building has received special attention, and the results indicate that bee keepers and entomologists have entertained erroneous ideas concerning this phase of bee activity. In connection with the uses of the various parts of the legs a study was made of the methods of packing pollen. This work was carried on by Dr. D. B. Casteel and is to be continued during the summer of 1912.

THE PRODUCTION OF COMB HONEY.

Considerable attention has been given to the methods of producing and marketing comb honey and the circumstances under which comb-honey production is most profitable. Special attention has been given to the problem of swarm prevention and control, since this is especially difficult under comb-honey conditions. The methods of some of the leading comb-honey experts of the country have been studied. The results of this work are incorporated in Farmers' Bulletin No. 503, by George S. Demuth.

WINTERING.

The winter of 1911–12 was one of the worst on record in the loss of bees, and this has made it necessary and desirable to begin work on the methods of wintering bees. A study of bees in cellars just before their removal was made in New York, and special attention was given to moisture and temperature of the cellars and the stores provided the preceding autumn. This work will be continued.

UNCLASSIFIED WORK.

As always happens, much work has been done in the chief branches of the bureau which can not be classified. Investigations of nut insects and insects injurious to ornamental plants and shade trees have been continued. Correspondence on the subject of shade-tree insects has been very great. There has also been a tremendous interest in the subject of household insects, and many hundreds of inquiries have been received.

The unnoted and at the same time laborious and necessary work of determining specimens for the entomologists of the different agricultural experiment stations, of the agricultural colleges, and others, has been continued and has occupied more or less of the time of a number of the expert investigators connected with the bureau and stationed at Washington. During the fiscal year nearly 35,000 specimens were determined for outside persons.

There have not been so many publications issued during the year as during the previous fiscal year, partly owing to deficient funds.

Fifty-five separate numbers, however, have been published and distributed, and the number of printed pages of information contained in these publications has been much greater than that shown by the 75 numbers published the previous year, while the number of pages of proof read in the bureau has been practically double that for the fiscal year 1911.

PROPOSED WORK FOR THE FISCAL YEAR 1913.

With regard to the gipsy moth and the brown-tail moth, it is proposed during the coming year to clean such additional roadsides as may seem most necessary, but to give more particular attention to drawing in the infested border line by exterminating the moths in the outside towns, especially on the southwest and north, which are the lines of least resistance. There seems to be less hope of control on the northeast edge on account of the wind spread; that is to say, the destribution of the newly hatched caterpillars by the wind. When the wind blows from the west the larvæ go out to sea, and when it comes from the north or east it is usually so cool that there is little activity among the young caterpillars; but the south and southwest breezes are warm, the little larvæ are active, and spread occurs when they are spinning from the tree tops. Cooperative work with the other States, and inspection of forest products, such as lumber, cordwood, posts, poles, Christmas trees, and evergreen decorations, must be continued with the greatest vigilance. There is danger in the shipment of Christmas trees from the infested areas to Philadelphia, Chicago, and other cities, and inspection of this class of shipments is most difficult. Field work will be continued in the effort to determine the increase of the species in different selected localities. Observations on feeding habits will be followed up, and the laboratory experiments on food plants already begun will be continued. If sufficient data are obtained, cooperative work with owners of badly infested wood lots will be attempted in the effort to prevent further damage from the gipsy moth. Importation of such useful parasites as can be secured will be continued, probably on a smaller scale, and the study of the dispersion and increase of those already colonized will be continued.

The work on the boll weevil has been interfered with greatly by the floods in the Mississippi Valley, but so far as possible experiments with new forms of practical control will be conducted. Opportunities for the poisoning and square-gathering experiments have been found outside the flooded area. In addition to the work on the introduction of parasites, the determination of the status of the insect from time to time and the extent of its spread into new territory will be followed up.

In the work on tobacco insects, demonstrations of the means of control that have been perfected will be conducted on as large a scale as possible. The so-called mosaic disease, now known to be caused by insects, and the cigarette beetle will receive special attention.

The sugar-cane borer will be studied with especial reference to its possible connection with the so-called root-rot disease of sugar cane, and large experiments in the control of the Argentine ant at Hattiesburg, Miss., will be continued throughout the season, and especial attention will be given to the possibility of preventing the infestation of Florida orange groves by this pest. Experimental work against the rice water-weevil will be continued, and the work against the cotton red spider in South Carolina will be largely of a demonstrational character.

The work on the possible influence of insects in the carriage of pellagra will be continued in cooperation with the Public Health and Marine-Hospital Service and with the recently established pellagra commission of the New York Postgraduate School of Medicine.

With forest insects, especial attention will be paid to the subject of insects affecting chestnut and the chinquapin, and a detailed study of the relation of insects to the blight and other diseases affecting these trees. The damage by insects to the seeds of forest trees will be studied, and investigations of the reductions in value of living, fire-killed, insect-killed, and storm-felled timber caused by wood-boring insects will be carried on. Special studies of the more important groups of forest-tree insects will be made, and experiments will be carried on with different chemical wood preservatives as to their effect in preventing attack of wood-destroying insects, especially white ants or termites. The investigation of insect damage to telephone and telegraph poles, mine props, and posts and timbers used in railroads or other constructions will be continued, as well as the practical demonstration work on methods of locating and treating timber infested with Dendroctonus and other tree-killing insects. So much of the latter work has been done that it is believed that less of the educational work will be needed the coming year.

With insects affecting deciduous fruit trees, most of the investigations of the past year will be continued, especially those relating to the grape Phylloxera, the apple-tree borers, the pear thrips, the peach Lecanium, and the codling moth. It is hoped to conclude the work with grape insects in the Lake Erie Valley and to utilize the force there in other investigations. The completion of the codling-moth studies in Michigan and California renders it possible to attempt some other investigations in those States, and in California, specifically, inquiry with regard to currant and gooseberry insects will be started.

With regard to cereal and forage insects, the same problems will continue under investigation, and with the added funds appropriated it will be possible to concentrate with greater force upon the important problem of the alfalfa weevil.

Added funds for the investigation of insects affecting vegetable crops have been specifically designated for the purpose of increasing the facilities in the study of insects affecting sugar beets, and also for added work upon the onion thrips. The stations already established will be continued, and the general outline of the work given in earlier paragraphs in this report will be followed out.

In the case of citrus fruits and subtropical fruits in general the work at Lindsay, Cal., relating to the orange thrips and various leaf-feeding insects should be completed with this year's work, the thrips project having already reached the demonstrational stage. The white-fly work in Florida has also reached a substantial conclusion. It seems wise, however, to carry out a series of demonstrations in different sections of the State to show the effectiveness of a proper system of spraying kept up for a period of two years. This demonstration work has already been begun, and will be just the kind of an object lesson which will impress growers and will lead to the general adoption of an adequate system of direct control. A further effort may very properly be made to reintroduce the natural enemies and parasites of the white fly, discovered by Mr. Woglum in India, but it does not seem wise to do this under the present appropriation. The investigation of the use of hydrocyanic-acid gas in fumigating citrus trees in California terminated at the close of the fiscal year 1909–10, and a very satisfactory report was issued. The recommendations in this report have been generally adopted in southern California, but certain new problems have arisen owing to variations in results under different conditions, and there has been much demand during the two years intervening for a continuation and further rounding out of this investigation. This is gratifying as indicative of a keen interest in the subject and as an expression of approval of the value of the investigation already completed. It is therefore planned that this work be resumed, and that other special and related insect problems in southern California be taken up incidentally.

One of the most important problems of the year is the investigation of the Mediterranean fruit-fly, long recognized as one of the worst fruit pests in Australia, South Africa, and other countries where it has become established, and which has been found in the Hawaiian Islands and bids fair to be introduced into California. The imminence of the danger has led to an especial appropriation to be expended during the year and particularly for an attempt to control the fly in the Hawaiian Islands, thus limiting the danger of introduction into California. The territorial government of Hawaii has already made an appropriation, and is engaged in active work in cooperation with agents from the State of California paid by the State. It is planned to put an expert of the Bureau of Entomology in charge of the work and to prosecute as vigorously as may be all possible measures of control.

In bee culture the problem of successful wintering will be the next one to be attacked by the bureau. Preliminary work will be done during the coming fiscal year in this direction. The work upon bee diseases and the other lines of investigation indicated will be continued.

In the absence of a national quarantine and inspection law, such inspection work as can be carried on must necessarily be along the same lines as heretofore. Where such inspection can be determined to be of service in preventing the introduction of the gipsy moth and brown-tail moth direct from Europe into new points in New York, the expense of this service can probably be provided for under the appropriation for preventing spread of moths, but all further expense must necessarily be defrayed by individual States. The bureau will act as a general notifier and consulting agent, but beyond this its powers are limited.[1]

PLANS FOR WORK RECOMMENDED FOR THE YEAR ENDING JUNE 30, 1914.

I beg to recommend that you consider the desirability of estimating for an addition of $37,500 to the sum appropriated for the fiscal year 1913 in your estimates for 1914. It is suggested that this sum can be expended to great advantage in the following manner: $5,000 to be added to the cotton boll weevil investigations; $10,000 to the investigations of the Argentine ant in an attempt to prevent the further spread of this destructive species; $5,000 to the investigations of forest insects; $10,000 to the investigations of deciduous fruit insects; $5,000 to the investigations of insects affecting vegetable and truck crops, and $2,500 to the apicultural investigations.

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[1] See footnote, page 37.

I beg to recommend further that the offices of executive assistant and chief clerk be combined, as in the Weather Bureau, so as to read in the appropriation act "One chief clerk and executive assistant," and I further recommend that the compensation of this official be increased to $2,500, and that in place of "one chief clerk, $1,800; one clerk, class 4," the act should be altered to read "two clerks, class 4."

It is further recommended that the salary of the chief of the bureau be increased to $5,000.

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